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INT CL[5] G01S, G08B, H04B

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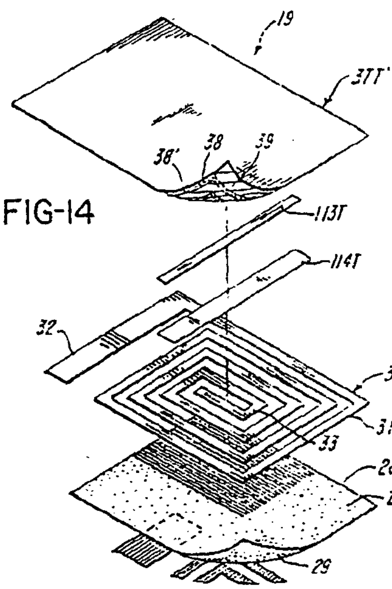
(54) **Deactivatable tags for use in electronic article surveillance systems and methods of making them**

(57) A deactivatable tag 19 for use in an electronic article surveillance system comprises a support on which is mounted a resonant circuit formed in part by a spiral conductor 31. The resonant circuit is responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the resonant circuit in an interrogation zone. Coatings 113T, 114T form an activatable connection which can be activated by subjecting the tag 19 to a high level of energy above that causing the resonant circuit to be detected at the interrogation zone. Activation of the activatable connection causes the resonant circuit to be deactivated.

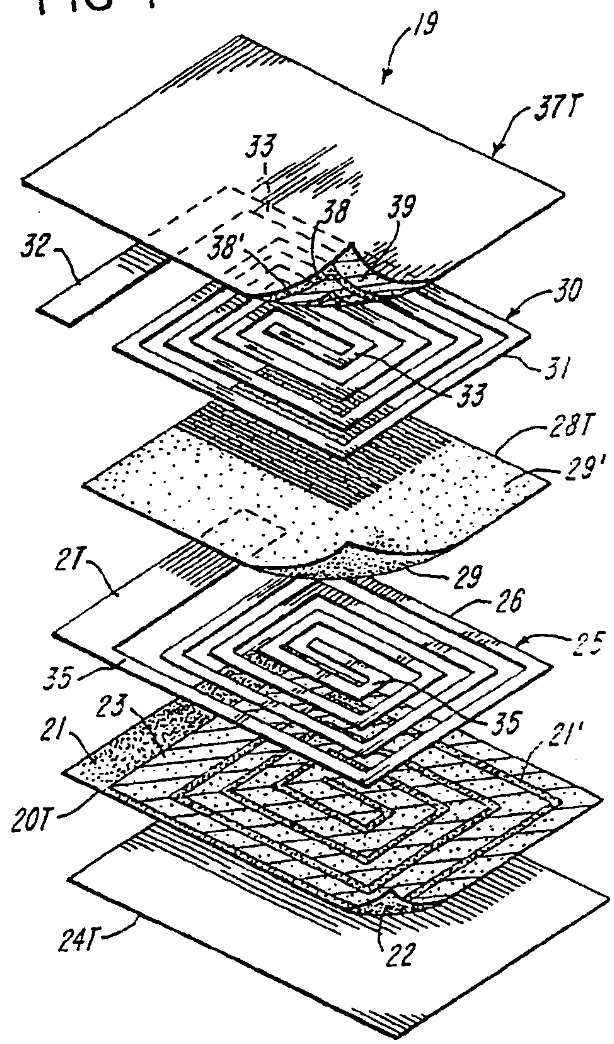
FIG-14



The date of filing shown above is that provisionally accorded to the application in accordance with the provisions of Section 15(4) of the Patents Act 1977 and is subject to ratification or amendment.

GB 2 234 885 A

FIG-1


19
37T
33
38
39
38'
32
30
31
33
28T
29'
27
29
26
25
35
35
23
21
21'
20T
24T
22

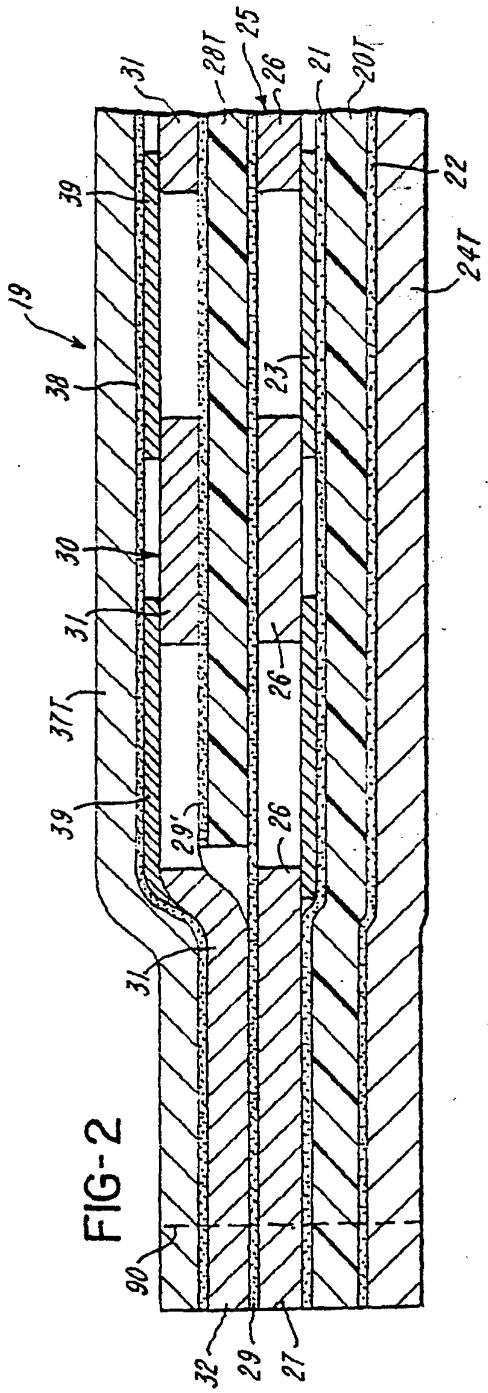

31
28T
25
26
21
20T
39
22
24T
19
38
23
30
31
26
37T
39
29'
26
31
90
32
29
27

FIG-2

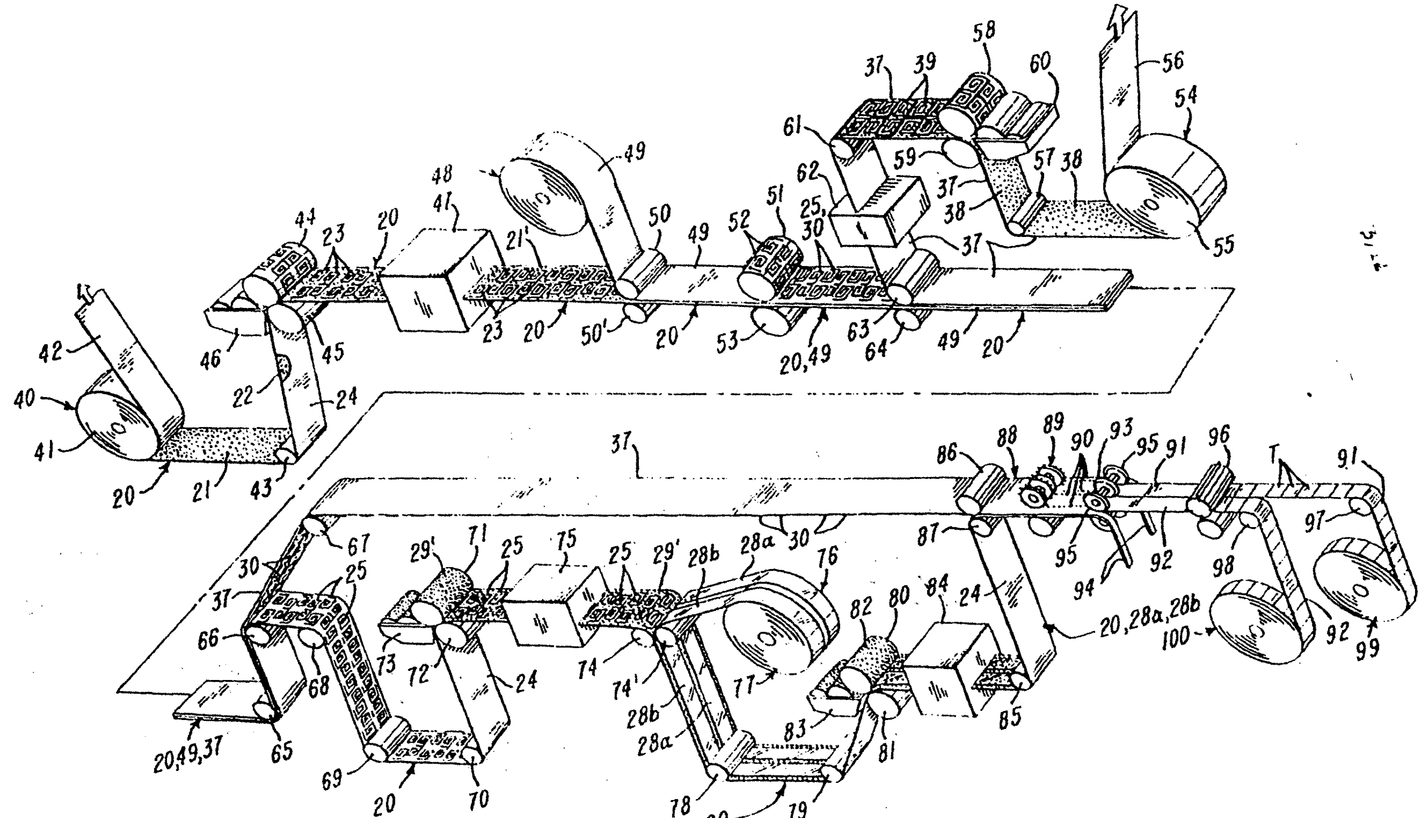


FIG-3

FIG-4

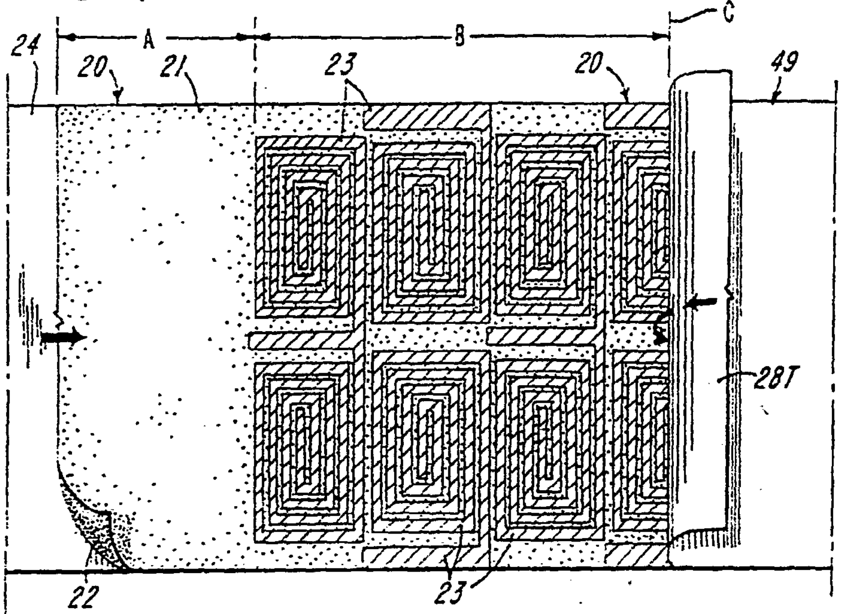

A
B
C
24
20
21
23
20
49
28T
22
23

FIG-5

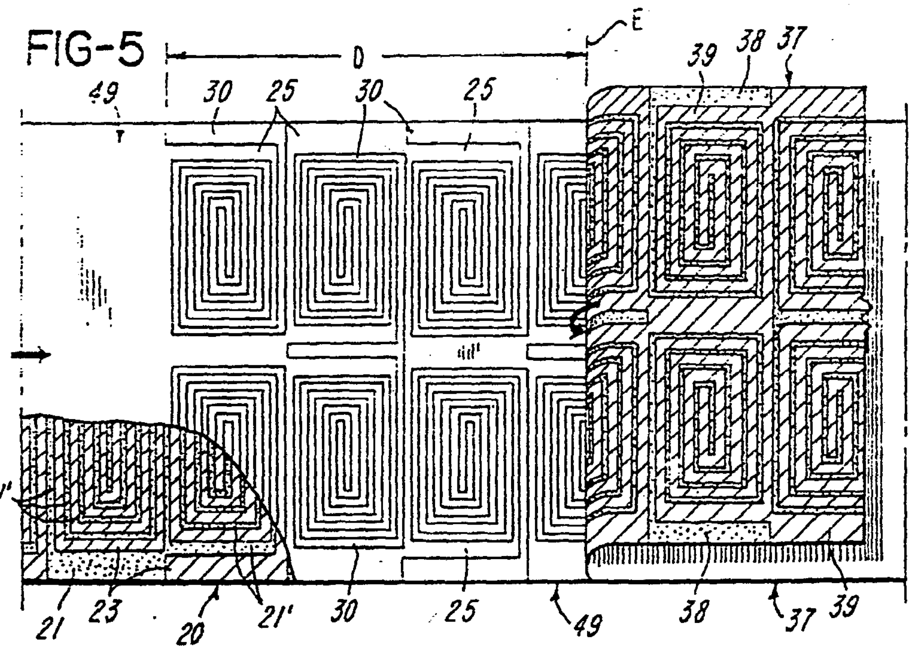

D
E
49
30
25
30
25
39
38
37
21'
21
23
20
21'
30
25
49
38
37
39

FIG-6

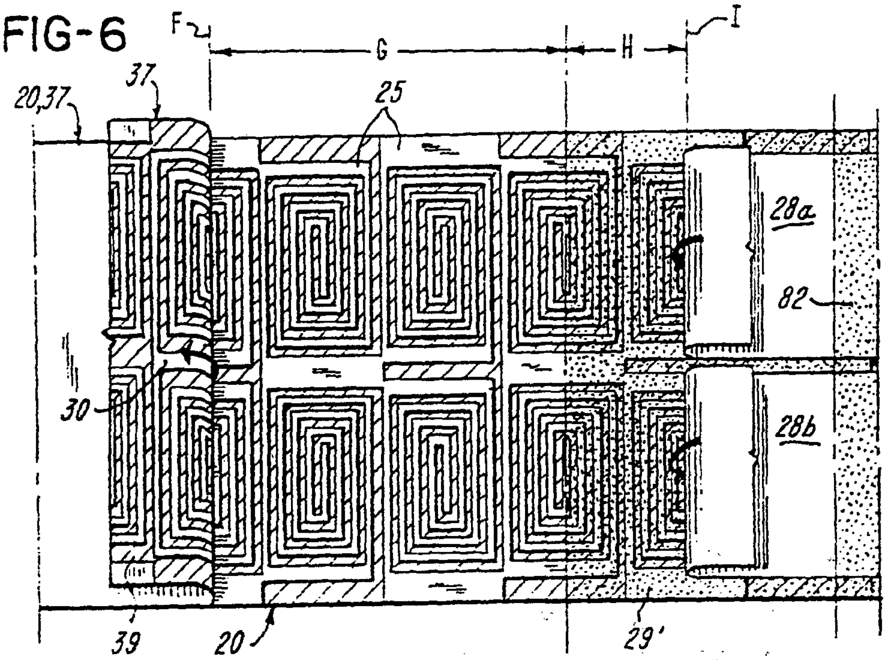

F
G
H
I
20,37
37
25
28a
82
30
28b
39
20
29'

FIG-7

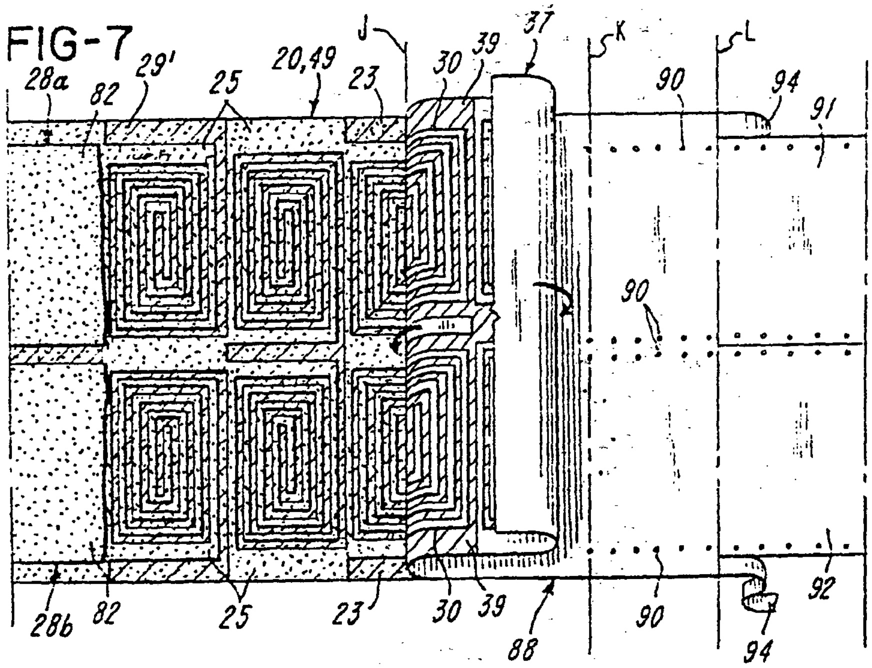

J
K
L
28a
82
29'
25
20,49
23
30
39
37
90
94
91
28b
88
92

FIG-8

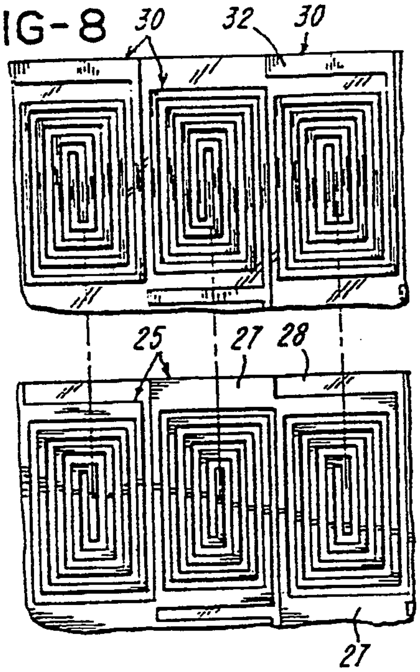


FIG-9

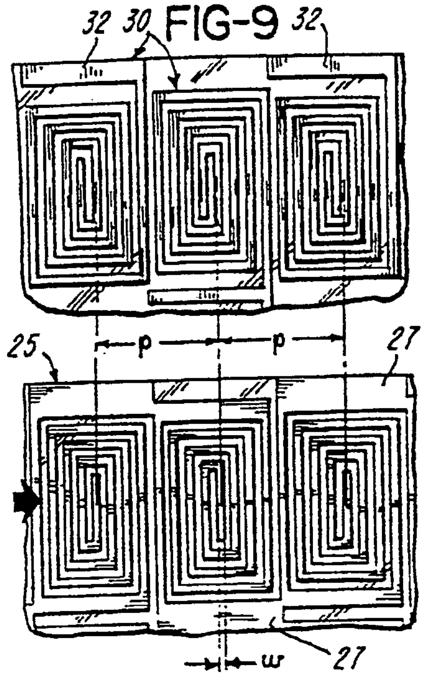


FIG-10

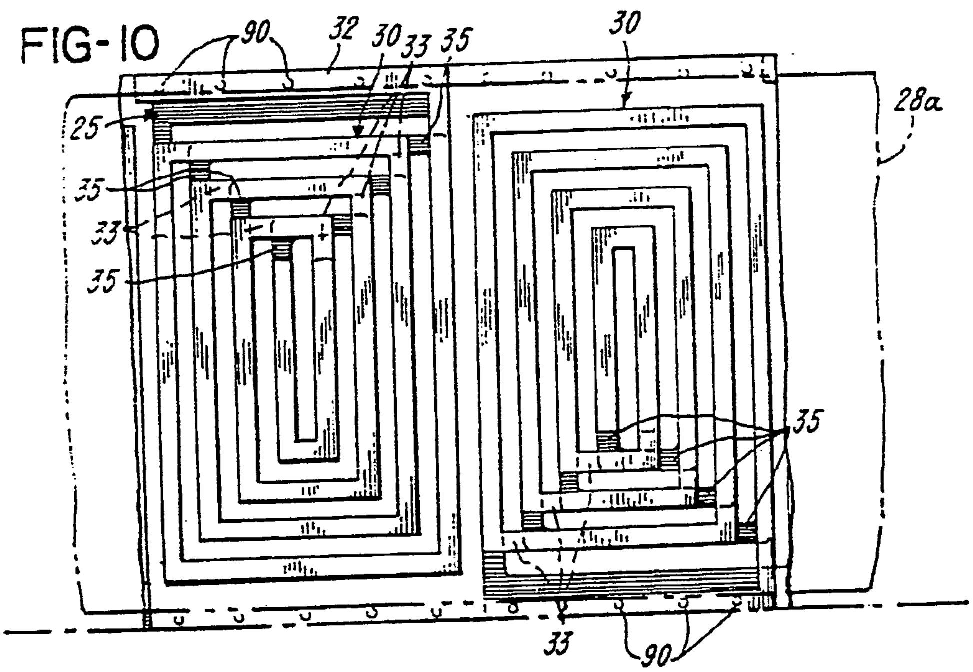


FIG-11

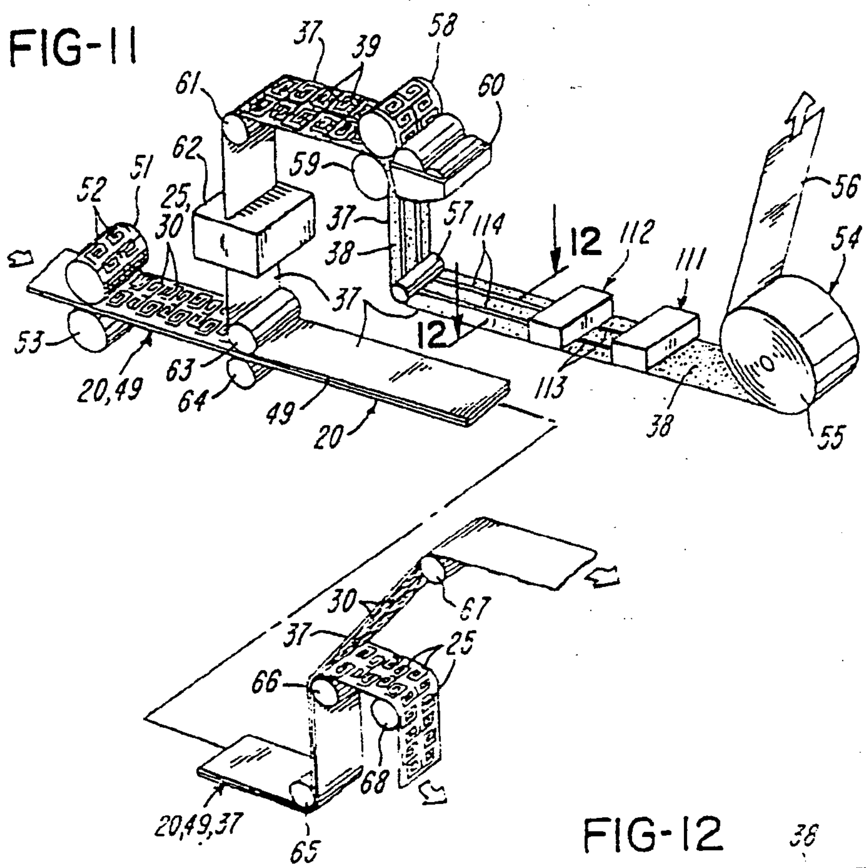


FIG-12

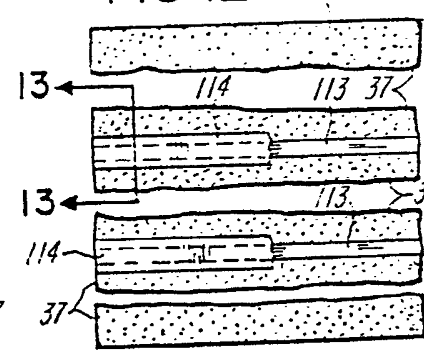


FIG-13

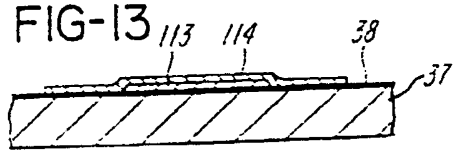


FIG-14

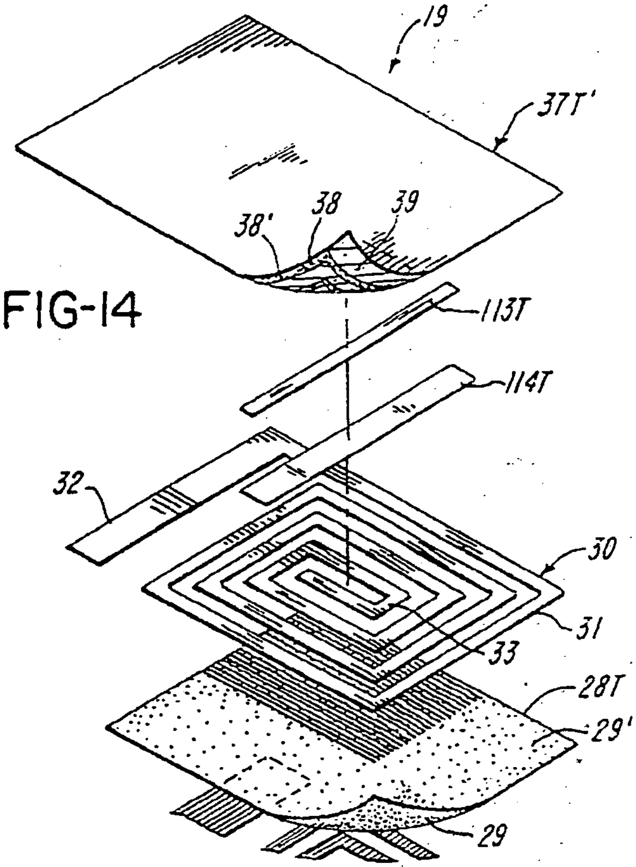

19
37T'
38'
38
39
113T
114T
32
30
31
33
28T
29'
29

FIG-15

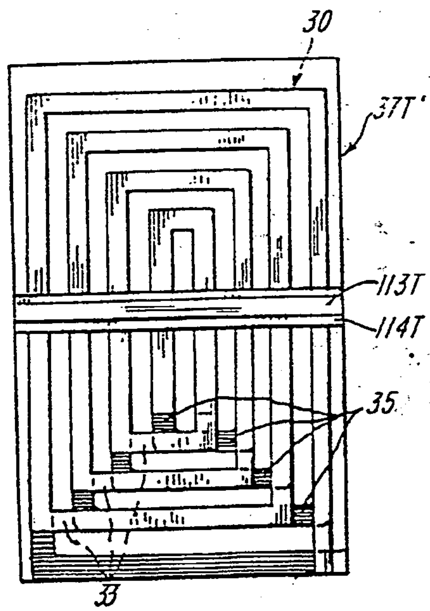

30
37T'
113T
114T
35
33

FIG-16

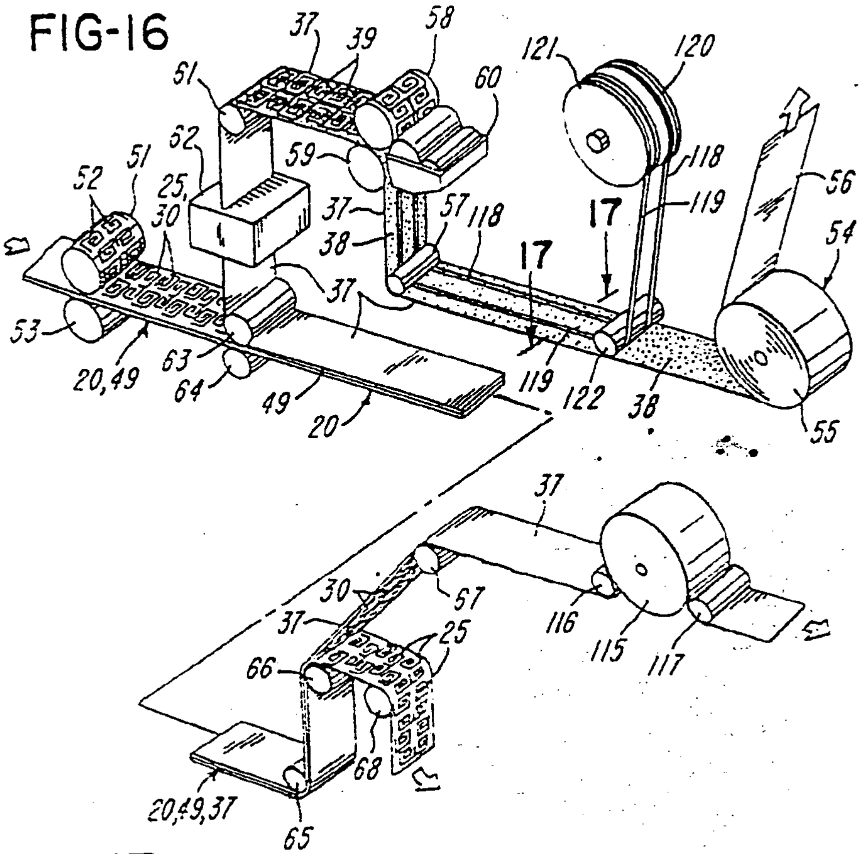


FIG-17

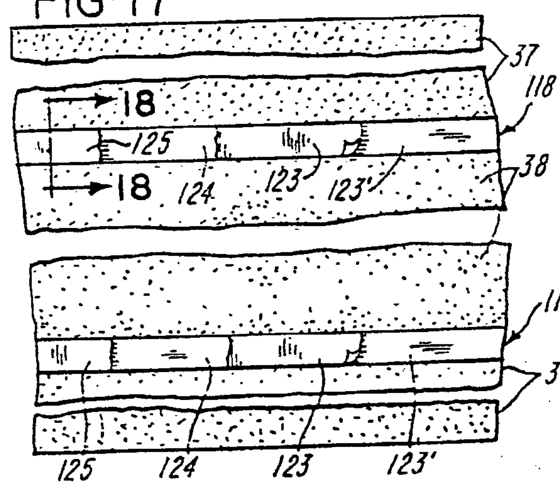


FIG-18

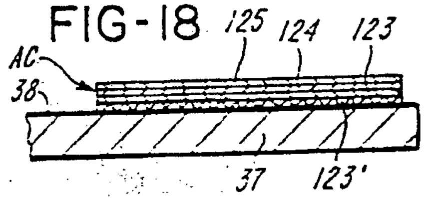
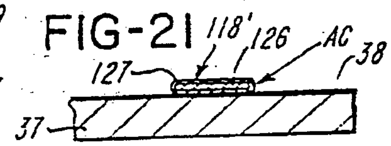


FIG-21



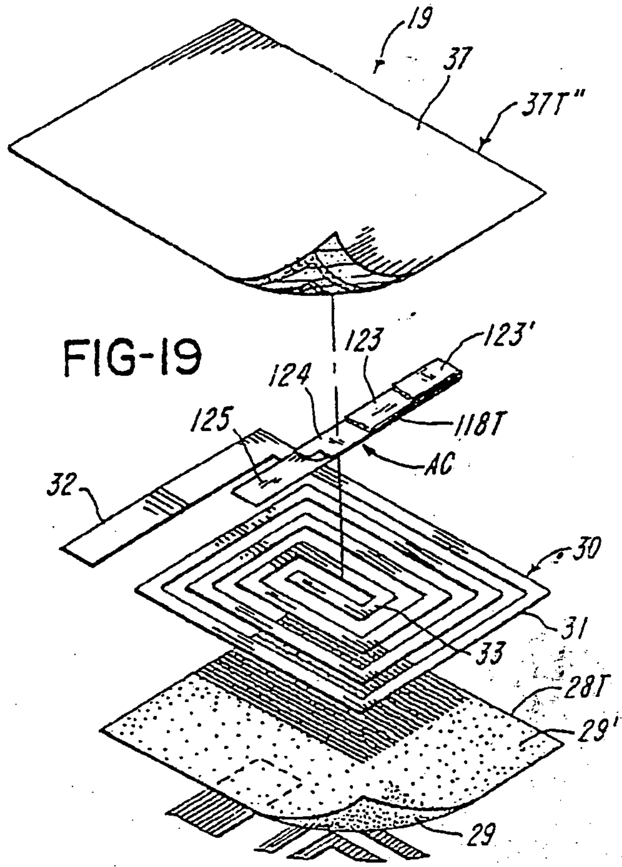

19
37
37T"
123
123'
124
125
118T
AC
32
30
31
33
28T
29'
29

FIG-19

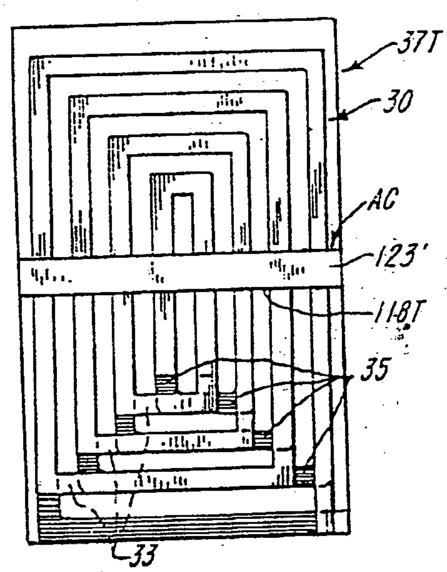
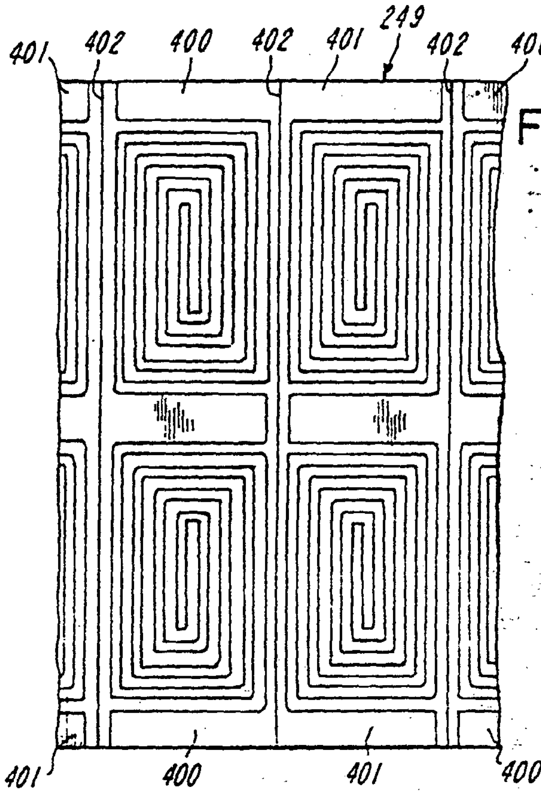

37T"
30
AC
123'
118T
35
33

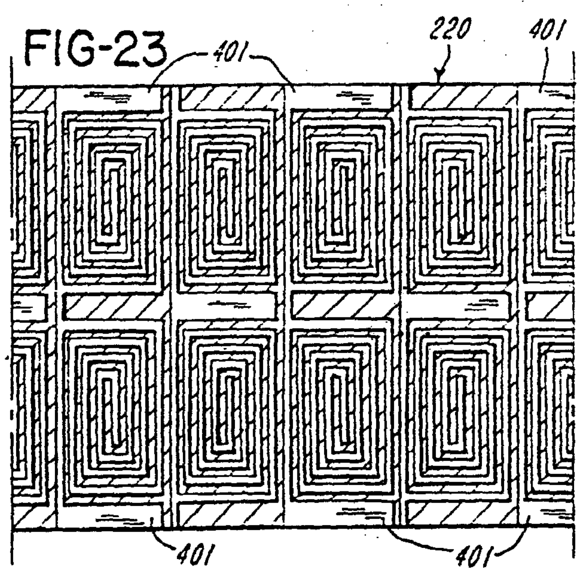
FIG-20



401
402
400
402
401
249
402
400
401
400
401
400

FIG-22

FIG-23



401
220
401
401
401

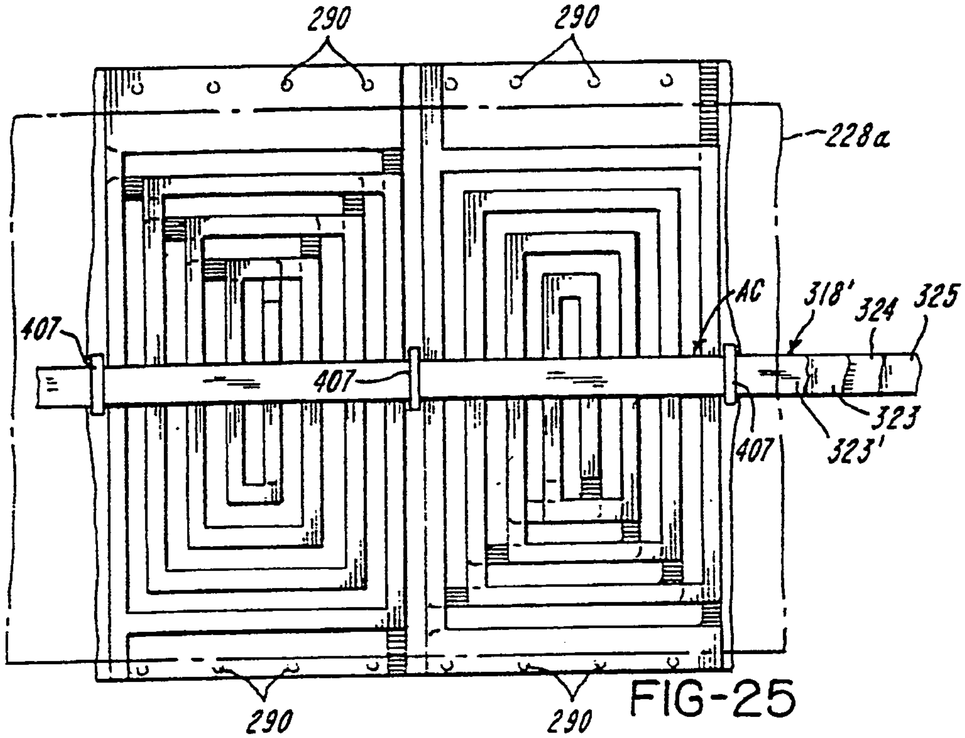
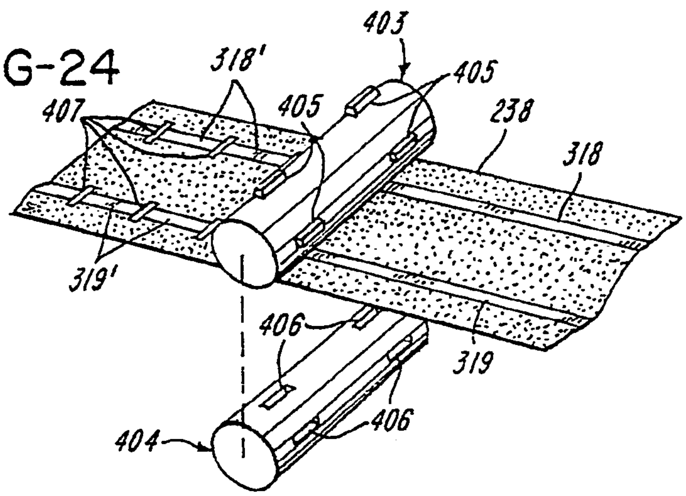

290
290
228a
407
407
AC
318'
324
325
323
323'
407
290
290

FIG-25

FIG-24


403
318'
405
405
407
238
318
319'
406
319
404
406

TAGS FOR USE IN ELECTRONIC ARTICLE SURVEILLANCE SYSTEMS AND METHODS OF MAKING THEM

This application is divided out of United Kingdom patent application no. 8722481 filed 24th September 1987.

This invention relates to tags for use in electronic article surveillance systems, and to methods of making such tags.

The prior art includes the following documents: U.S. Patents 3,240,647; 3,624,631; 3,810,147; 3,913,219; 4,482,874; 4,555,291 and 4,567,473; and French patent 2,412,923.

The invention in its various aspects is defined in the appended claims to which reference should now be made.

One particular problem that has been found is that a deactivatable tag can be accidentally deactivated prematurely before the tag is ready to be willfully deactivated. Such deactivation can occur during manufacture or even after manufacture such as during storage or when a web of the tags is being printed upon in a

marking machine. The deactivation can occur due to static electricity which builds up and can arc in a longitudinal direction along the web between adjacent resonant circuits if the resonant circuits touch each other or are too close to each other and additionally if a normally non-conductive breakdown deactivator extends longitudinally from resonant circuits-to-resonant circuits.

In a preferred embodiment of this invention this problem is overcome by spacing the resonant circuits from each other in the longitudinal direction of the web and by separating the web of deactivation material into separate spaced strips so that there is one deactivator strip for each resonant circuit. The premature deactivation of adjacent resonant circuits is then prevented, even though both the conductive material of which the resonant circuits are formed and the deactivator material is originally in web form.

Brief Description of the Drawings

The invention will now be described in detail by way of example, with reference being made to the drawings, in which:

FIGURE 1 is an exploded perspective view of a tag in accordance with an embodiment of the invention;

FIGURE 2 is a fragmentary sectional view of the tag in FIGURE 1;

FIGURE 3 is a diagrammatic perspective view illustrating method of making a tag in accordance with the invention;

FIGURE 4 is a diagrammatic top plan view showing a mask having been applied to a first adhesive coated web and showing an electrically conductive web being laminated to the masked first adhesive coated web;

FIGURE 5 is a diagrammatic top plan view showing the conductive web having been cut to provide first and second pairs of conductors and showing a masked second adhesive coated web being laminated to the conductive web;

FIGURE 6 is a diagrammatic top plan view showing the first coated web with the first conductors adhered thereto being separated relative to the second coated web with the second conductors adhered thereto, and showing further the first coated web having been recoated with adhesive and two webs of dielectric being laminated to the recoated first coated web, and showing the dialectric webs having been coated with adhesive;

FIGURE 7 is a diagrammatic top plan view showing the second coated web with the second conductors adhered thereto having been shifted and laminated over and to the dialectric webs and to the first coated web with the first conductors to provide a composite tag web, showing the staking of the first and second conductors of each tag to provide resonant circuits for each tag, and showing slitting of the composite tag web to provide a plural series of composite tag webs;

FIGURE 8 is a vertically exploded view showing the first and second coated webs with the first and second conductors that result from cutting the electrically conductive web spirally;

FIGURE 9 is a top plan view showing the first and second coated webs shifted by a distance equal to the width of one conductor spiral plus the width of one conductor;

FIGURE 10 is a top plan vi w of two tags with the dielectric web shown in phantom lines;

FIGURE 11 is a fragmentary perspective view which, when taken together with the preceding figures of the drawings, illustrates an improved method of making deactivatable tags;

FIGURE 12 is a fragmentary top plan view taken along line 12--12 of FIGURE 11;

FIGURE 13 is a sectional view taken along line 13--13 of FIGURE 12;

FIGURE 14 is a fragmentary perspective view similar to FIGURE 1, but showing one embodiment of structure for deactivating the tag;

FIGURE 15 is a fragmentary top plan view of the tag shown in FIGURE 14;

FIGURE 16 is a fragmentary perspective view which, taken together with FIGURES 1 through 10, illustrated an alternative improved method of making deactivatable tags;

FIGURE 17 is a fragmentary top plan view taken along line 17--17 of FIGURE 16;

FIGURE 18 is a sectional view taken along line 18--18 of FIGURE 17;

FIGURE 19 is a fragmentary perspective view similar to FIGURE 14 but showing another embodiment of structure for deactivating the tag;

FIGURE 20 is a fragmentary top plan view of the tag shown in FIGURE 19;

FIGURE 21 is a sectional view similar to FIGURE 18 but showing an alternative structure for deactivating the tag;

FIGURE 22 is a top plan view of an alternative cut pattern for the web of conductive material corresponding generally to D in FIGURE 5;

FIGURE 23 is a top plan view of the alternative cut pattern with one-half of the conductive material removed and corresponding generally to G in FIGURE 6;

FIGURE 24 is a diagrammatic perspective view showing the manner in which the webs of deactivating material are cut into stripes or strips; and

FIGURE 25 is a top plan view of a pair of longitudinally spaced resonant circuits with separate respective deactivator strips.

Description of the Preferred Embodiments

Referring initially to FIGURE 1, there is shown an exploded view of a tag generally indicated at 19. The tag 19 is shown to include a sheet 20T having pressure sensitive adhesive 21 and 22 on opposite faces thereof. A mask 23 in a spiral pattern covers a portion of the adhesive 21 and a release sheet 24T is releasably adhered to the adhesive 22. The mask 23 renders the adhesive 21 which it covers non-tacky or substantially so. A conductor spiral indicated generally at 25 includes a spiral conductor 26 having a number of turns. The conductor 26 is of substantially the same width throughout its length except for a connector bar 27 at the outer end portion of the conductor spiral 26. There is a sheet of dielectric 28T over and adhered to the conductor spiral 25 and the underlying sheet 20T by means of adhesive 29. A conductor spiral generally indicated at 30 includes a spiral conductor 31 having a number of turns. The conductor 31 is adhered to adhesive 29' on the dielectric 28T. The conductor 31 is substantially the same width throughout its length except for a connector bar 32 at the outer end portion of the conductor spiral 30. The conductor spirals 25 and 30 are generally aligned in face-to-face relationship except for portions 33 which are not face-to-face with the conductor 26 and except for portions 35 which are not face-to-face with the conductor 31. A sheet 37T has a coating of a pressure sensitive adhesive 38 masked off in a spiral pattern 39. The exposed adhesive 38' is aligned with the conductor spiral 30. Adhesive is shown in FIGURE 1 by heavy stippling and the masking is shown in FIGURE 1 by light stippling with cross-hatching. The connector bars 27 and 32 are

electrically connected, as for example by staking 90. It should be noted that the staking 90 occurs where connector bars 27 and 32 are separated only by adhesive 29. There is no paper, film or the like between the connector bars 27 and 32. Accordingly, the staking disclosed in the present application is reliable.

With reference to FIGURE 3, there is shown diagrammatically a method for making the tag 19 shown in FIGURES 1 and 2. A roll 40 is shown to be comprised of a composite web 41 having a web 20 with a full-gum or continuous coatings of pressure sensitive adhesive 21 and 22 on opposite faces thereof. The web 20 is "double-faced" with adhesive. A release liner or web 42 is releasably adhered to the upper side of the web 20 by the pressure sensitive adhesive 21, and the underside of the web 20 has a release liner or web 24 releasably adhered to the pressure sensitive adhesive 22. As shown, the release liner 42 is delaminated from the web 20 to expose the adhesive 21. The adhesive coated web 20 together with the release liner 24 pass partially about a sandpaper roll 43 and between a pattern roll 44 and a back-up roll 45 where mask patterns 23 are applied onto the adhesive 21 to provide longitudinally recurring adhesive patterns 21'. Masking material from a fountain 46 is applied to the pattern roll 44. With reference to FIGURE 4, the portion marked A represents the portion of the web 20 immediately upstream of the pattern roll 44. The portion marked B shows the mask patterns 23 printed by the roll 44. The patterns 23 are represented by cross-hatching in FIGURE 4. With reference to FIGURE 3, the web 20 now passes through a dryer 47 where the mask patterns 23 are dried or cured. The adhesive 21 is rendered non-tacky at the mask patterns 23. A web 49 of planar, electrically conductive material such as copper or aluminum from a roll 48 is laminated onto the coated web 20 as they pass between laminating rolls 50 and 50'. Reference character C in FIGURE 4 denotes the line where lamination of the webs 20 and 49

occurs. With reference to FIGURE 3, the laminated webs 20 and 49 now pass between a cutting roll 51 having cutting blades 52 and a back-up roll 53. The blades 52 cut completely through the conductive material web 49 but preferably do not cut into the web 20. The blades 52 cut the web 49 into a plurality of series of patterns 25 and 30 best shown in the portion marked D in FIGURE 5. With reference again to FIGURE 3, there is shown a roll 54 comprised of a composite web 55 having a web 37 with a full-gum or continuous coating of pressure sensitive adhesive 38 and a release liner 56 releasably adhered to the adhesive 38 on the web 37. The release liner 56 is separated from the web 37 and the web 37 passes about a sandpaper roll 57. From there the web 37 passes between a pattern roll 58 and a back-up roll 59 where mask patterns 39 are applied onto the adhesive 38 to render the adhesive 38 non-tacky at the mask patterns 39 to provide longitudinally recurring adhesive patterns 38' (FIGURE 1). Masking material from a fountain 60 is applied to the pattern roll 58. The masking material of which the patterns 23 and 39 are comprised is a commercially available printable adhesive deadener such as sold under the name "Aqua Superadhesive Deadener" by Environmental Inks and Coating Corp, Morganton, North Carolina. From there the web 37 passes partially about a roll 61 and through a dryer 62 where the mask patterns 39 are dried or cured. The adhesive 38 is rendered non-tacky at the mask patterns 39. From there the webs 20, 49 and 37 pass between laminating rolls 63 and 64. FIGURE 5 shows that lamination occurs along line E where the web 37 meets the web 49. When thus laminated, each adhesive pattern 21' registers only with an overlying conductor spiral 25 and each adhesive pattern 38' registers only with an underlying conductor spiral 30.

The webs 20, 37 and 49 pass successively partially about rolls 65 and 66 and from there the web 37 delaminates from the web 20 and passes partially about a roll 67. At the place of delamination, the web 49 separates into two webs of

conductor spirals 25 and 30. As shown in FIGURE 6, delamination occurs along the line marked F. When delamination occurs, the conductor spirals 30 adhere to the adhesive patterns 38' on the web 37, and the conductor spirals 25 adhere to the adhesive patterns 21' on the web 20. Thus, the conductor spirals 30 extend in one web and the spirals 25 extend in another web. The web 20 passes partially about rolls 68, 69 and 70 and from there pass between an adhesive coating roll 71 and a back-up roll 72. Adhesive 29 from a fountain 73 is applied to the roll 71 which in turn applies a uniform or continuous coating of adhesive 29 to the web 20 and over conductive spirals 25. The portion marked G in FIGURE 6 shows the portion of the web 20 and conductor spirals 25 between the spaced rolls 66 and 72. The portion marked H shows the portion of the web 20 between the spaced rolls 72 and 74. With reference to FIGURE 3, the web 20 passes through a dryer 75 where the adhesive 29 is dried. A plurality, specifically two laterally spaced dielectric webs 28a and 28b wound in rolls 76 and 77 are laminated to the web 20 as the webs 20, 28a and 28b pass between the rolls 74 and 74'. This laminating occurs along reference line I indicated in FIGURE 6. With reference to FIGURE 3, the web 20 with the conductor spirals 25 and the dielectric webs 28a and 28b pass about rolls 78 and 79 and pass between an adhesive applicator roll 80 and a back-up roll 81. The roll 80 applies adhesive 29' received from a fountain 83 to the webs 28a and 28b and to the portions of the web 20 not covered thereby. From there, the webs 20, 28a and 28b pass through a dryer 84 and partially about a roll 85.

The web 37 which had been separated from the web 20 is laminated at the nip of laminating rolls 86 and 87 along a line marked J in FIGURE 7 to provide a composite tag web generally indicated at 88. The webs 20, 28a, 28b and 37 are laminated between rolls 86 and 87 after the conductor spirals 30 have been shifted longitudinally with respect to the

conductor spirals 25 so that each conductor spiral 30 is aligned or registered with an underlying conductor spiral 25. The shifting can be equal to the pitch of one conductor spiral pattern as indicated at p (FIGURE 9) plus the width w of one conductor, or by odd multiples of the pitch p plus the width w of one conductor. Thus, each pair of conductor spirals 25 and 30 is capable of making a resonant circuit detectable by an appropriate article surveillance circuit.

FIGURE 8 shows the web 20 and the web 37 rotated apart by 180°. FIGURE 9 shows the web 20 and the web 37 rotated apart by 180° and as having been shifted with respect to each other so that the conductor spirals 25 and 30 are aligned. As best shown in FIGURE 10, the dielectric 28a terminates short of stakes 90 resulting from the staking operation. By this arrangement the stakes 90 do not pass through the dielectric 28a (or 28b). FIGURE 10 shows the conductor spirals 25 and 30 substantially entirely overlapped or aligned with each other, except as indicated at 35 for the conductor spiral 25 and as indicated at 33 for the conductor spiral 30. Each circuit is completed by staking the conductor bars 27 and 32 to each other as indicated at 90 or by other suitable means. The staking 90 is performed by four spiked wheels 89 which make four stake lines 90 in the composite web 88. The spiked wheels 89 pierce through the conductor bars 27 and 32 and thus bring the conductor bars 27 and 32 into electrically coupled relationship. The web composite 88 is slit into a plurality of narrow webs 91 and 92 by slitter knife 93 and excess material 94 is trimmed by slitter knives 95. The webs 91 and 92 are next cut through up to but not into the release liner 24 by knives on a cutter roll 96, unless it is desired to cut the tags T into separated tags in which event the web 88 is completely severed transversely. As shown, the webs 91 and 92 continue on and pass about respective rolls 97 and 98 and are wound into rolls 99 and 100. As shown in FIGURE 7, the staking 90

takes place along a line marked K and the slitting takes place along a line marked L.

The sheet 37T, the dielectric 28T, the sheet 20T and the sheet 24T are respectively provided by cutting the web 37, the web 28a (or 28b), the web 20 and the web 24.

FIGURE 11 is essentially a duplicate of a portion of FIGURE 3, but a pair of coating and drying stations generally indicated at 111 and 112 where respective coatings 113 and 114 in the form of continuous stripes are printed and dried. The coating 113 is conductive and is applied directly onto the pressure sensitive adhesive 38 on the web 37. The coatings 114 are wider than the respective coatings 113 which they cover to assure electrical isolation, as best shown in FIGURES 12 and 13. The coatings 114 are composed of a normally non-conductive activatable material. The remainder of the process is the same as the process taught in connection with FIGURES 1 through 10.

With reference to FIGURES 14 and 15, there is shown a fragment of the finished tag 37T' with the coatings 113 and 114 having been severed as the tag 37T' is severed from the tag web as indicated at 113T and 114T respectively. As shown the coating 113T is of constant width and thickness throughout its length and the coating 114T is of constant width and thickness but is wider than the coating 113T. The coating 113T which is conductive is thus electrically isolated from the conductor spiral 30. The coatings 113T and 114T comprise an activatable connection AC which can be activated by subjecting the tag to a high level of energy above that for causing the resonant circuit to be detected at an interrogation zone.

FIGURE 16 is essentially a duplicate of a portion of FIGURE 3, but a pair of webs 118 and 119 are adhered to the adhesive 38 on the web 37. The webs 118 and 119 are wound onto spaced reels 120 and 121. The webs 118 and 119 pass from the reels 120 and 121 partially about a roll 122. The webs 118 and 119 are spaced apart from each other and from

the side edges of the web 37. The webs 118 and 119 are identical in construction, and each includes a thin layer of conductive material 123 such as copper or aluminum on a layer of paper 123', a high temperature, normally non-conductive, activatable, conductor-containing layer 124, and a low temperature, normally non-conductive, activatable, conductor-containing layer 125. The layers 124 and 125 contain conductors such as metal particles or encapsulated carbon. The layer 125 bonds readily when heated, so a drum heater 115 is positioned downstream of the roll 67 (FIGURES 3 and 16) and upstream of the rolls 86 and 87 (FIGURE 3). The heated circuits 30, heat the layer 125 and a bond is formed between the circuits 30 and the layer 125. Rolls 116 and 117 (FIGURE 16) guide the web 37 about the drum heater 115. The heating of the layer 125 has some tendency to break down the normally non-conductive nature of the layer 125, but this is not serious because the layer 124 is not broken down or activated by heat from the drum heater 115.

With reference to FIGURES 19 and 20, there is shown a fragment of a finished tag 37T" with the webs 118 and 119 having been severed so as to be coextensive with the tag 37T" and is indicated at 118T. The web strip or stripe 118T includes the paper layer 123', the conductive layer or conductor 123 and the normally non-conductive layers 124 and 125. The layers 123, 124 and 125 are shown to be of the same width and comprise an activatable connection AC. Both coatings 124 and 125 electrically isolate the conductor 123 form the conductor spiral 30. In other respects the tag 37T" is identical to the tag 37T and is made by the same process as depicted for example in FIGURE 3.

The embodiment of FIGURE 21 is identical to the embodiment of FIGURES 16 through 20 except that instead of the webs 118 and 119 there are a pair of webs comprised of flat bands, one of which is shown in FIGURE 21 and is depicted at 118'. The band 118' is comprised of a web or band conductor 126 of a conductive material such as copper

enclosed in a thin coating of a non-conductive material 127. The band 118' comprises an activatable connection AC. As seen in FIGURE 21, the upper surface of the coating 127 electrically isolates the conductor 126 from the conductor spiral 30. The band 118' is processed according to one specific embodiment, by starting with coated motor winding wire, Specification No. 8046 obtained from the Belden Company, Geneva, Illinois 60134 U.S.A. and having a diameter of about 0.004 inch (0.1mm) with an insulating coating of about 0.0005 (0.013), flattening the wire between a pair of rolls into a thin band having a thickness of 0.0006 inch (0.015mm). Thus processed the insulating coating is weakened to a degree which breaks down when the resulting tag is subjected to a sufficiently high energy level signal. The coating 118' is thus termed a "breakdown coating" because it acts as an insulator when the tag is subjected to an interrogation signal at a first energy level but no longer acts as an electrical insulator when subjected to a sufficently higher energy level signal. The conductor 126 accordingly acts to short out the inductor 30 at the higher energy level signal.

The embodiments depicted in FIGURES 11 through 20 and described in connection therewith enable the tag 37T' or 37T" to be detected in an interrogation zone when subjected to a radio frequency signal at or near the resonant frequency of the resonant circuit. By sufficiently increasing the energy level of the signal, the normally non-conductive coating 114 (or 114T), or 124 and 125 becomes conductive to alter the response of the resonant circuit. This is accomplished in a specific embodiment by using a normally non-conductive coating to provide an open short-circuit between different portions of the conductor spiral 30.

When the tag is subjected to a high level of energy, in the embodiments of FIGURES 11 through 15, and 16 through 20 the normally non-conductive coating becomes conductive and shorts out the inductor. Thus, the resonant circuit is no

longer able to resonate at the proper frequency and is unable to be detected by the receiver in the interrogation zone.

While the illustrated embodiments disclose the activatable connection AC provided by an additional conductor as extending across all the turns of the conductor spiral 30 and by a normally non-conductive material or breakdown insulation electrically isolating the conductor from the conductor spiral 30 and also extending across all of the turns of the conductor spiral 30, the invention is not to be considered limited thereby.

By way of example, not limitation, examples of the various coatings are stated below:

I. <u>For the embodiment of FIGURES 11 through 15</u>

A. Examples of the normally non-conductive coating 114 are:

<u>Example 1</u>	<u>Parts by Weight</u>
cellulose acetate (C.A.)	
powder (E-398-3)	60
acetone	300

Mixing procedure: Solvate C.A. powder in acetone with stirring.

C.A./copper dispersion	
above C.A. solution (16%T.S.)	15
copper 8620 powder	2.5

Mixing procedure: Add copper powder to C.A. solution with adequate stirring to effect a smooth metallic dispersion.

<u>Example 2</u>	
acrylvid B-48N	
(45% in toluene)	30
acetone	20
isopropanol	3
Above solution (25%T.S.)	10
copper 8620 powder	5

Mixing procedure: disperse copper powder into B-48N solution (Percent copper powder is 60-70% on dry weight basis.)

B. Examples of the conductive coating 113 are:

Example 1	Parts by Weight
acryloid B-67 acrylic (45% in naptha)	25
naptha	16
silflake #237 metal powder	42

Mixing procedure: add metal powder to solvent and wet out. Add solvated acrylic and stir well to disperse. Mix or shake well prior to use. (75% to 85% conductive metal on dry weight basis.)

Example 2	
acryloid NAD-10 (40% in naptha)	10
silflake #237 metal powder	20

Mixing procedure: Add metal powder to acrylic dispersion with stirring.

Example 3	
S & V aqueous foil ink OFG 11525 (37%T.S.)	5
silflake #237 metal powder	8

Mixing procedure: Add metal powder to aqueous dispersion slowly with adequate agitation to effect a smooth metallic dispersion.

I. For the embodiment of FIGURES 16 through 20

A. Examples of the low temperature coating 125 are:

Example 1	Parts by Weight
acryloid NAD-10 dispersion (30% T. Solids)	10
naptha	2
copper 8620 copper powder	5

Mixing procedure: wet copper powder with Naptha and disperse completely. Add NAD-10 dispersion slowly with stirring. Mix well or shake before use.

<u>Example 2</u>

polyester resin (K-1979)	28
ethanol	10
isopropanol	10
ethyl acetate	20
above polyester solution	10
copper 8620 powder	2.5

Mixing procedure: add copper powder to polyester solution while stirring to effect a smooth metallic dispersion.
(48% copper powder on dry basis)

B. Examples of the high temperature coating 124 are:

<u>Example 1</u>

cellulose acetate butyrate (C.A.B.)(551-0.2)	40
toluene	115
Ethyl Alcohol	21
Above C.A.B. solution (22.7%)	10
toluene	2
copper 8620 copper powder	5

Mixing procedure: wet copper powder with solvent and add C.A.B. solution with stirring.

<u>Example 2</u>

acryloid B-48N (45% in toluene)	30
acetone	20
isopropanol	3
Above solution (25%T.S.)	10

copper 8620 copper powder
(Dry weight basis -- copper is 60-70%)

Mixing procedure: add copper powder to above solution with proper agitation to effect a smooth metallic dispersion.

The materials used in the above examples are obtainable from the following suppliers in the U.S.A.:

Acryloid NAD-10, Acryloid B-48N and Acryloid B-67, Rohm & Hass, Philadelphia, Pennsylvania;

Cellulose Acetate (E-398-3) and Cellulose Acetate Butyrate (551-0.2), Eastman Chemical Products, Inc., Kingsport, Tennessee;

Copper 8620, U.S. Bronze, Flemington, New Jersey;

Silflake #237, Handy & Harmon, Fairfield, Connecticut;

Krumbhaar K-1979, Lawter International, Inc., Northbrook, Illinois;

Ageuous foil ink OFG 11525, Sinclair & Valentine, St. Paul, Minnesota.

FIGURES 22 through 25 depict an improved method over the embodiment of FIGURES 11 through 15, over the embodiment of FIGURES 16 through 20, and over the embodiment of FIGURE 21. The method of the embodiment of FIGURES 22 through 25 relates to the formation of longitudinally spaced deactivatable resonant circuits arranged in a web. The longitudinal spacing of the resonant circuits assures that electrostatic charge that can prematurely deactivate one resonant circuit in the web cannot arc longitudinally to the other resonant circuits in the web to cause their premature deactivation. Where possible, the same reference character will be used in the embodiment of FIGURES 22 through 25 as in the embodiment of FIGURES 16 through 20 to designate components having the same general construction and function, but increased by 200. It will be appreciated that reference is also made to FIGURES 3, 5 and 6.

With reference initially to FIGURE 22, web 249 of planar, electrically conductive material is cut in patterns of conductor spirals 400 and 401. The cut patterns include lateral or transverse lines of complete severing 402. The conductor spirals 400 and 401 are generally similar to the conductor spirals 25 and 30, however, inspection of FIGURE 5 will indicate that all conductor spirals 25 and 30 are in very close proximity to each other in the longitudinal direction, being spaced only by knife cuts themselves. In addition, spirals 25 are connected to each other and spirals 30 are connected to each other. In contrast, in the embodiment of FIGURES 22 through 25, only the conductor spirals 400 and 401 between adjacent lines of complete severing 402 are connected to each other. In the method of FIGURES 22 through 25, reference may be had to FIGURE 3 which shows that the conductor spiral webs 20 and 37 are separated as they pass partly about roll 66, thereafter dielectric material webs 28a and 28b are applied, the webs 20 and 37 are shifted longitudinally by the pitch of one conductor spiral 400 (or 401) plus the width of one conductor, and thereafter the webs 20 and 37 are re-laminated as they pass between rolls 86 and 87.

As is evident from FIGURE 23, once the web of resonant circuits 401 is stripped away, the resultant web 220 has pairs of resonant circuits 401 that are longitudinally spaced apart. In like manner, the pairs of resonant circuits 400 in the stripped away web (corresponding to the web 37 in FIGURE 3), are also spaced apart longitudinally.

The method of the embodiment of FIGURES 22 through 25, relates to production of deactivatable tags. The illustrated arrangement for deactivating the tags utilizes the arrangement taught in the embodiment of FIGURES 16 through 20 with the exception that the deactivator webs 318 and 319 (corresponding to the deactivator webs 118 and 119 in FIGURE 16 for example), are separated into longitudinally spaced deactivator strips or stripes 318' and 319'. The

separation is accomplished in accordance with the specific embodiment shown in FIGURE 24, by punching out portions or holes 407 of the web 238 and the deactivator webs 318 and 319. For this purpose, a diagrammatically illustrated rotary punch 403 and a rotary die 404 are used. The rotary punch 403 has punches 405 and the rotary die 404 has cooperating die holes 406. The resultant holes 407 are wider than the spacing between the resonant circuits. The holes 407 are thus registered with the margins of the longitudinally spaced resonant circuits are shown in FIGURE 25. Thus, static electricity cannot arc between resonant circuits in a longitudinal direction and static electricity cannot arc between deactivator strips 318' (or 319').

Other embodiments and modifications of the invention will suggest themselves to those skilled in the art, and all such of these as come within the spirit of this invention are included within its scope as best defined by the appended claims.

CLAIMS

1. Method of making a deactivatable tag for use in an electronic article surveillance system, comprising the steps of: providing a resonant circuit responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the resonant circuit in an interrogation zone, the circuit including an inductor having a spiral conductor, providing an additional conductor, and positioning the additional conductor adjacent the spiral conductor while electrically isolating the additional conductor from the spiral conductor by a normally non-conductive material which can be rendered conductive to deactivate the tag in response to a second energy level signal at an energy level higher than the first energy level signal.

2. Method of deactivating a tag made by the method defined in claim 1, further including the steps of applying the second energy level signal to the tag to render the non-conductive material conductive so that the additional conductor alters the characteristics of the inductor and hence the circuit to prevent the emission of the alarm signal.

3. Method of making a deactivatable tag for use in an electronic article surveillance system, comprising the steps of: providing a resonant circuit responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the resonant circuit in an interrogation zone, the circuit including an inductor having a spiral conductor, applying a first coating across at least a portion of the spiral conductor with the first coating being normally non-conductive but which can be rendered conductive in response to a second energy level signal at an energy level higher than the first energy level signal, and applying a conductive second coating over the first coating in electrically isolated relationship to the spiral conductor so that upon receipt of the second energy level signal the first coating becomes conductive and the second coating

thereby becomes electrically coupled to the conductor to alter the characteristics of the inductor to prevent emission of the alarm signal.

4. Method of making a deactivatable tag for use in an electronic article surveillance system, comprising the steps of: providing a resonant circuit responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the circuit in an interrogation zone, the circuit including an inductor having a spiral conductor with a plurality of turns, providing an open short-circuit between two turns of the spiral conductor, the step of providing the open short-circuit including the step of isolating the two turns from each other by a normally non-conductive material which can be rendered conductive to short circuit the inductor in response to receipt of a second energy level signal at an energy level higher than the first energy level signal.

5. Method of making a deactivatable tag for use in an electronic article surveillance system, comprising the steps of: providing a resonant circuit responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the resonant circuit in an interrogation zone, the circuit including an inductor having a spiral conductor with a plurality of turns, providing an open short-circuit between two turns of the spiral conductor, the step of providing the open short-circuit including the step of applying a first coating across at least a portion of one of the turns wth the first coating being normally non-conductive but which can be rendered conductive in response to a second energy level signal at an energy level higher than the first energy level signal, and applying a conductive second coating between the two turns and over the first coating so that receipt of the second energy level signal of the inductor is short-circuited and consequently the characteristics of the inductor are altered to prevent emission of the alarm signal.

6. Method of making a deactivatable tag for use in an

electronic article surveillance system, comprising the steps of: providing a resonant circuit responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the circuit in an interrogation zone, the circuit including an inductor having a spiral conductor with a plurality of turns, and positioning a web of conductive material adjacent one of the spiral conductors, with the conductive material web having a layer of a normally non-conductive material electrically isolating the conductive material web from the spiral conductor but wherein the normally non-conductive material can be rendered conductive in response to a second energy level signal at an energy level higher than the first energy level signal to alter the characteristics of the inductor to prevent emission of the alarm signal.

7. Method of making a deactivatable tag for use in an electronic article surveillance system, comprising the steps of: providing a first web with a first series of first spiral conductors and a second web with a series of second spiral conductors, providing a web of conductive material having a layer of normally non-conductive material, positioning the conductive material web with the normally non-conductive layer adjacent either the first or the second series of conductors, adhering the first and second webs to each other, connecting the conductors of the first and second webs to each other to provide a series of resonant circuits in a composite web, separating the composite web into tags each having a first conductor and a second conductor coupled to each other, and wherein the normally non-conductive layer can be rendered conductive in response to an energy level higher than that level necessary to activate the tag.

8. Method of making a deactivatable tag for use in an electronic article surveillance system, comprising the steps of: providing a first web, printing conductive material on the first web, printing non-conductive material on the first web over the conductive material, providing a second web, first and second spiral conductors positioned between the first and second webs,

adhering the webs to each other with pairs of the first and second spiral conductors connected to provide resonant circuits, wherein the normally non-conductive material can be rendered conductive in response to an energy level higher than that level necessary to activate the tag, and separating the webs to provide tags each having a deactivatable circuit.

9. Method of making a deactivatable tag for use in an electronic article surveillance system, comprising the steps of: providing a resonant circuit responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the resonant circuit in an interrogation zone, the circuit including an inductor having a spiral conductor, and providing an activatable connection to the spiral conductor including normally non-conductive, conductor-containing material which can be rendered conductive in response to a second energy level signal at an energy level higher than the first energy level signal.

10. Method as defined in claim 9, wherein the step of providing an activatable connection includes the step of applying the normally non-conductive material between spaced but connected portions of the spiral conductor.

11. Method as defined in claim 9, wherein the step of providing an activatable connection includes the step of connecting spaced portions of the spiral conductor with an additional conductor electrically isolated from the spaced portions by the normally non-conductive material.

12. A deactivatable tag for use in an electronic article surveillance system, the tag comprising: a support, a resonant circuit on the support, the resonant circuit being responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the resonant circuit in an interrogation zone, the resonant circuit including a spiral conductor, a deactivating conductor adapted to connect spaced portions of the spiral conductor to each other, normally non-conductive material

electrically isolating the deactivating conductor from at least one portion of the spiral conductor, and wherein the normally non-conductive material can be rendered conductive to deactivate the resonant circuit in response to a second energy level signal higher than the first energy level signal.

13. Method of making a deactivatable tag for use in an electronic article surveillance system, comprising the steps of: providing a resonant circuit responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the resonant circuit in an interrogation zone, and positioning an insulated conductor having a breakdown coating in contact with the circuit for deactivating the tag in response to a second energy level signal at an energy level higher than the first energy level signal.

14. Method as defined in claim 13, wherein the insulated conductor is made by flattening an insulated conductive metal wire.

15. A deactivatable tag for use in an electronic article surveillance system, the tag comprising: a support, a resonant circuit on the support, the resonant circuit being responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the resonant circuit in an interrogation zone, the resonant circuit including a spiral conductor having turns, a stripe of normally non-conductive material across at least two turns, a stripe of conductive material isolated from the two turns by the normally non-conductive material, and wherein the normally non-conductive material can be rendered conductive to deactivate the resonant circuit in response to a second energy level signal higher than the first energy level signal.

16. A deactivatable tag as defined in claim 15, wherein the stripe extends across all the turns of the spiral conductor.

17. A deactivatable tag for use in an electronic article

surveillance system, the tag comprising: a support, a resonant circuit on the support, the resonant circuit being responsive to receipt of a first energy level signal to emit an alarm signal to indicate the presence of the resonant circuit in an interrogation zone, the resonant circuit including a spiral conductor, means for altering the signal emitted by the resonant circuit to prevent detection of the presence of the circuit in the interrogation zone, the signal altering means including normally non-conductive material connected to the spiral conductor, and wherein the normally non-conductive conductor-containing material can be rendered conductive in response to a second energy level signal at an energy level higher than the first energy level signal.

18. A deactivatable tag as defined in claim 17, wherein the signal altering means further includes conductive material electrically isolated from the spiral conductor by the normally non-conductive material.

19. A deactivatable tag as defined in claim 17, wherein a spiral conductor includes a plurality of turns, the normally non-conductive material constituting a stripe across at least two of the turns, a stripe of conductive material on the normally non-conductive material stripe and across the same two turns, and wherein the stripe of conductive material is electrically isolated from those two turns by the normally non-conductive material stripe.

20. A deactivatable tag as defined in claim 19, wherein both the normally non-conductive material stripes and the conductive material stripe extend across all the turns of the spiral conductor.

21. A deactivatable tag for use in an electronic article surveillance system, the tag comprising; a support, a resonant circuit on the support, the resonant circuit being responsive to a first energy level signal to emit an alarm signal to indicate the presence of the resonant circuit in an interrogation zone,

and an insulated conductor having a breakdown coating and being in contact with the circuit for deactivating the tag in response to a second energy level signal at an energy level higher than the first energy level signal.

22. Method of making a deactivatable tag for use in an electronic article surveillance system, comprising the steps of: providing a first web with a first series of longitudinally spaced first spiral conductors and a second web with a series of longitudinally spaced second spiral conductors, providing spaced strips of conductive material having a layer of normally non-conductive material, positioning the strips with the normally non-conductive layer adjacent either the first or the second series of conductors, adhering the first and second webs to each other, connecting the conductors of the first and second webs to each other to provide a series of spaced resonant circuits in a composite web and there being one of said strips for each resonant circuit, separating the composite web into tags each having a first conductor and a second conductor coupled to each other, and wherein the normally non-conductive layer can be rendered conductive in response to an energy level higher than that level necessary to activate the tag.

23. Method of making a deactivatable tag for use in an electronic article surveillance system, comprising the steps of: providing a first longitudinally extending web, printing conductive material on the first web, printing non-conductive material on the first web over the conductive material, providing discontinuities in the conductive material and the non-conductive material printed thereover to provide longitudinally spaced strips, providing a second web, providing longitudinally spaced pairs of first and second spiral conductors positioned between the first and second webs, adhering the webs to each other with pairs of the first and second spiral conductors connected to provide spaced resonant circuits with a strip in contact with each circuit but without contacting any other circuit, wherein the normally non-conductive material can be rendered conductive in response to an energy level higher than that level necessary

to activate the tag, and separating the webs to provide tags each having a deactivatable circuit.

24. Method of making deactivatable tags for use in an electronic article surveillance system, comprising the steps of: providing a longitudinally extending web of longitudinally spaced resonant circuits, providing a continuous longitudinally extending web of a deactivator, and separating the deactivator web into a series of longitudinally spaced strips with each strip being registered with one resonant circuit and out of contact with any other resonant circuit.

25. A method of making tags for use in an electronic article surveillance system, substantially as herein described with reference to the drawings.

26. A tag for use in an electronic article surveillance system, substantially as herein described with reference to the drawings.

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